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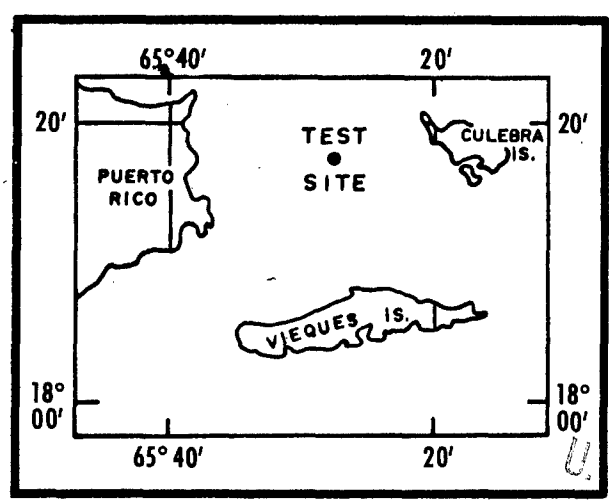
INFORMAL REPORT

MARINE BIOFOULING IN VIEQUES SOUND, PUERTO RICO, AN INTERIM REPORT APRIL 1964 TO FEBRUARY 1969



JUNE 1969

NAVAL OCEANOGRAPHIC OFFICE
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INFORMAL REPORT

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ABSTRACT

In 1964, the U.S. Naval Oceanographic Office began a marine biofouling sampling program in Vieques Sound, Puerto Rico. The sampling program is continuing until May 1970. This program is one of a series of sampling programs to determine the character and extent of marine fouling communities in various marine biological provinces of the world.

The Vieques Sound program is being conducted by exposing test panels at 50- and 95-foot depths in 100 feet of water. From April 1964 to February 1969, 103 panels were recovered and analyzed for fouling and boring organisms.

Settlement of fouling larvae was found to occur throughout the year in Vieques Sound. The rate of fouling, however, was quite variable from month to month, apparently depending on whether water currents bring larvae of potential foulers from distant brood sites. A strong affinity exists between the fauna of the Vieques Sound fouling communities and the fauna of the South Florida/Bahamas region.

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This report has been reviewed and is approved for release as an UNCLASSIFIED Informal Report.

L. B. BERTHOLF
Director, Nearshore Surveys Division

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The author also is indebted to the EOD divers from the U.S. Naval Station in San Juan who collected panels and maintained the test site with remarkable efficiency and a refreshing "CAN DO" attitude.

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I. INTRODUCTION

In April 1964, the U.S. Naval Oceanographic Office (NAVOCEANO) began a marine biofouling sampling program in Vieques Sound, Puerto Rico. The program is being conducted at one site, 18°18'N, 65°26'W, by exposing test panels at 50- and 95-foot depths in 100 feet of water (Fig. 1). From April 1964 to February 1969, 103 panels were recovered from the test site. This interim report presents the results from the analyses of these panels. The sampling program at Vieques Sound is continuing until May 1970, and a final report will be prepared when the program is completed.

Previous to this NAVOCEANO program, no detailed test panel studies of fouling communities (both foulers and borers) had been made in Puerto Rican waters. The William F. Clapp Laboratories (BUYARDS and DOCKS, 1951) exposed test panels in the harbors of San Juan and Roosevelt Roads in 1951, but these exposures were primarily to study marine borers. A series of moored mines exposed off San Juan during World War II were found to have accumulated up to 3 inches of unspecified fouling organisms after 6 months of exposure (Moritz, 1944).

II. OBJECTIVES

The NAVOCEANO fouling study in Vieques Sound is one of a series of programs to determine the character and extent of the biofouling communities in various faunal provinces; i.e., regions in which the animal inhabitants are more or less the same. The objectives of this study were as follows: (1) to identify the attaching organisms, (2) to ascertain if these organisms attach in sufficient numbers to affect military operations, and (3) to determine growth rates, seasonality, productivity, and patterns of distribution of coastal fouling communities. Data from this particular program will supplement published information and, together with data from other regions being studied, will eventually result in a worldwide atlas of biofouling conditions.

III. METHODS OF COLLECTION AND ANALYSIS

Biofouling organisms were collected on standard NAVOCEANO test panels (6 x 12-inch sections of wood and asbestos, attached back to back). Panels were exposed at intervals sufficient to yield monthly and longer term information. The longest exposure was for 17 months. The panels were planted and recovered from the test site by Explosive Ordnance Disposal (EOD) divers (Fig. 2) from the U.S. Naval Station at San Juan. Additionally, temperature measurements were made and water samples for salinity analysis were collected at each test depth and at the surface whenever test panels were removed. After recovery, the panels were preserved in alcohol and shipped to NAVOCEANO for analysis.

At NAVOCEANO, the analysis consisted of identifying the various organisms, determining the number and size of each, estimating the percent of surface covered by foulers, and estimating (by radiographic technique) the degree of wood damage by marine borers. The fouling material then was scraped cleanly from the panels and oven dried at 100°C until the weight was constant.

Maximum size measurements are used to calculate growth rates, which are an index of the well-being of various species. Growth rates also are useful in determining exposure time of recovered derelict objects. The dry weight of fouling per square meter of substrate provides a statistical measure of the biofouling productivity of the area.

IV. DISPOSITION OF DATA

All data are retained on file at NAVOCEANO. A reference collection of specimens and the dried biomass scrapings, radiographs, and data summary sheets are filed under Operation Numbers 924001 and 928032.

V. DISCUSSION

The waters of Vieques Sound are oceanic and tropical in character. The range of salinity values does not exceed 34.5 - 36.5 ‰, and the temperatures vary from a high of 84.5°F (29.2°C) in September to a low of 78.0°F (25.6°C) in February and March. Larvae of potential foulers showed no seasonal preference for settlement; attachment of one or more species occurred during all months of the year.

A total of 54 species of fouling organisms (foulers and borers) was collected at the Vieques Sound test site. Table I presents the relative abundance of biofouling organisms on the test panels. As expected, a strong affinity exists between the fauna of the Vieques Sound fouling communities and the fauna of the South Florida/Bahamas region (DePalma, 1969). More than two-thirds of the animal foulers collected at the Vieques Sound test site were common to both areas.

The rate of fouling (accumulation of organic material on the asbestos substrate per unit time) was light and extremely variable from month to month and from one year to the next (Table II), and wood damage by marine borers was also light, by nearshore tropical standards. Figures 3 through 8 are reproductions of radiographs of test panels showing wood damage by teredinid borers at each test level over a 12-month period. This normally light, but occasionally epidemic, settlement of fouling and boring organisms (see Figure 7) is probably related to the distance from the nearest land masses and potential brood sites (6 and 10 miles). At the Vieques Sound test site and in most other offshore areas, the fouling rate is dependent on the vagaries of water currents to deliver larvae of fouling and

boring organisms to the test surfaces. Once settled, the organisms grew rapidly (Fig. 9), indicating that the rate of fouling is not limited by deficiencies in the environment.

VI. ADDITIONAL WORK NEEDED IN THE REGION

Additional exposure sites are planned in Vieques Passage and at Roosevelt Roads Naval Station. Data from these sites will be useful to more clearly define the relationship between fouling rate and distance from shore.

VII. BIBLIOGRAPHY

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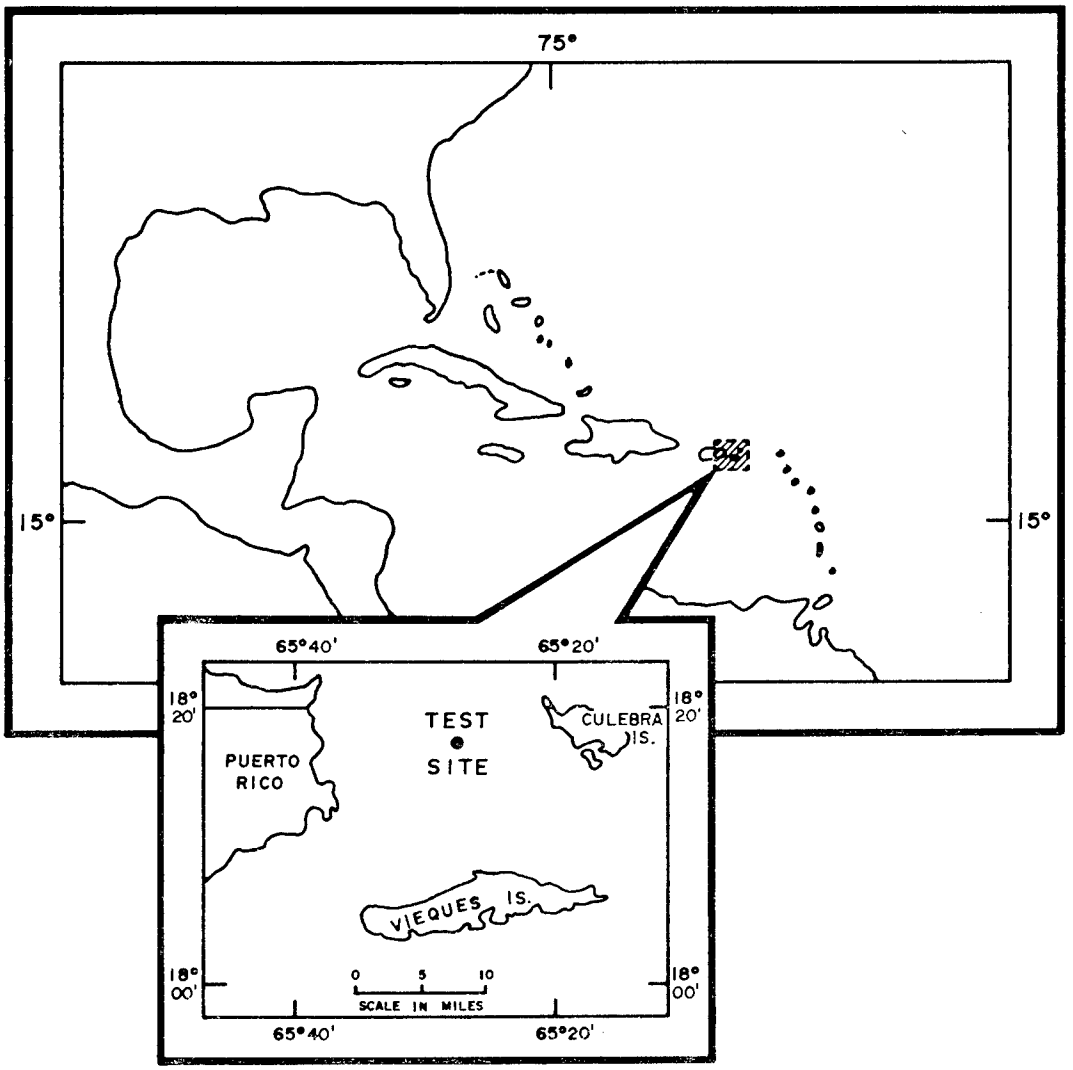

Figure 1. Location of Test Panels

Figure 2. EOD Diver Retrieving Test Panels

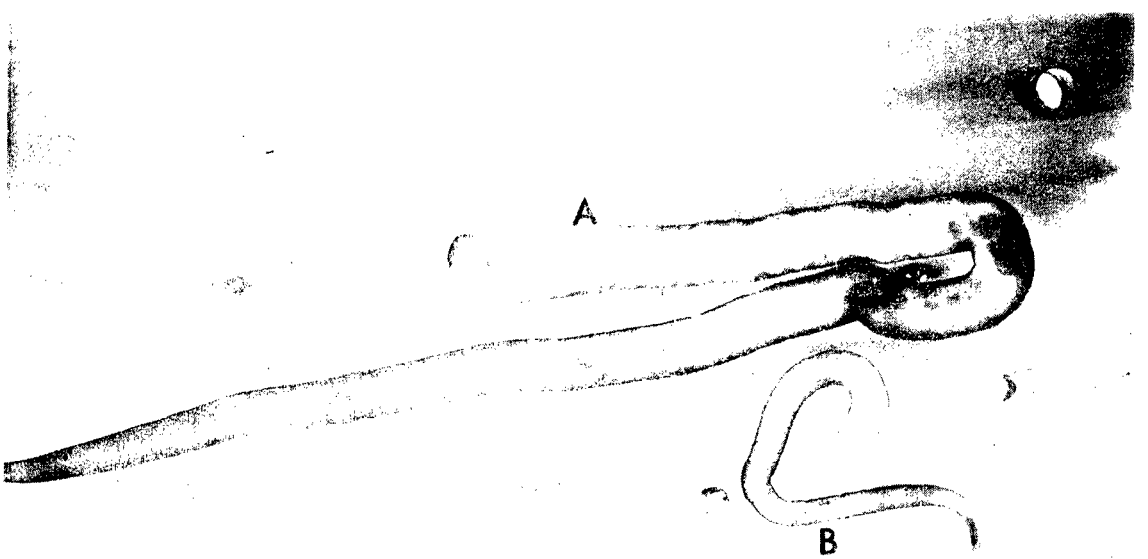

Figure 3. Radiograph of Test Panel Exposed in Vieques Sound for 4 Months at 95 Feet. Shells and pallets of four Lyrodus pedicellatus can be seen.

Figure 4. Radiograph of Test Panel Exposed in Vieques Sound for 8 Months at 50 Feet. Shells and pallets of (A) Teredora malleolus and (B) Bankia carinata can be seen.

Figure 5. Radiograph of Test Panel Exposed in Vieques Sound for 8 Months at 95 Feet. The tubes of teredine borers are lined with a calcareous substance which shows as a dark outline. The light area is the anterior or working end of the tube.

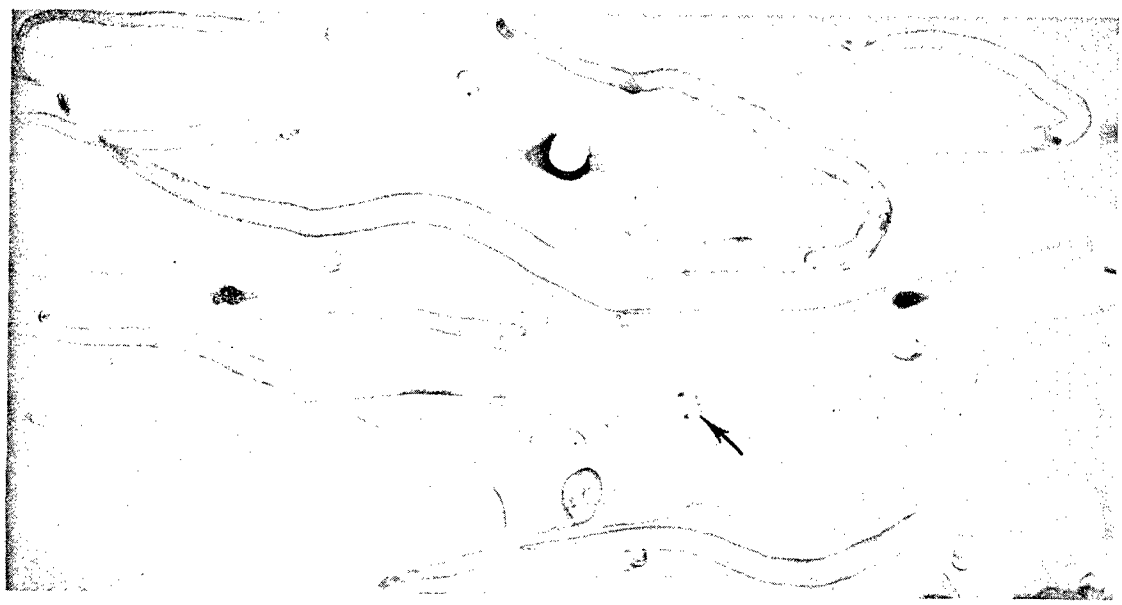

Figure 6. Radiograph of Test Panel Exposed in Vieques Sound for 10 Months at 50 Feet. Arrow shows shell in the boring position.

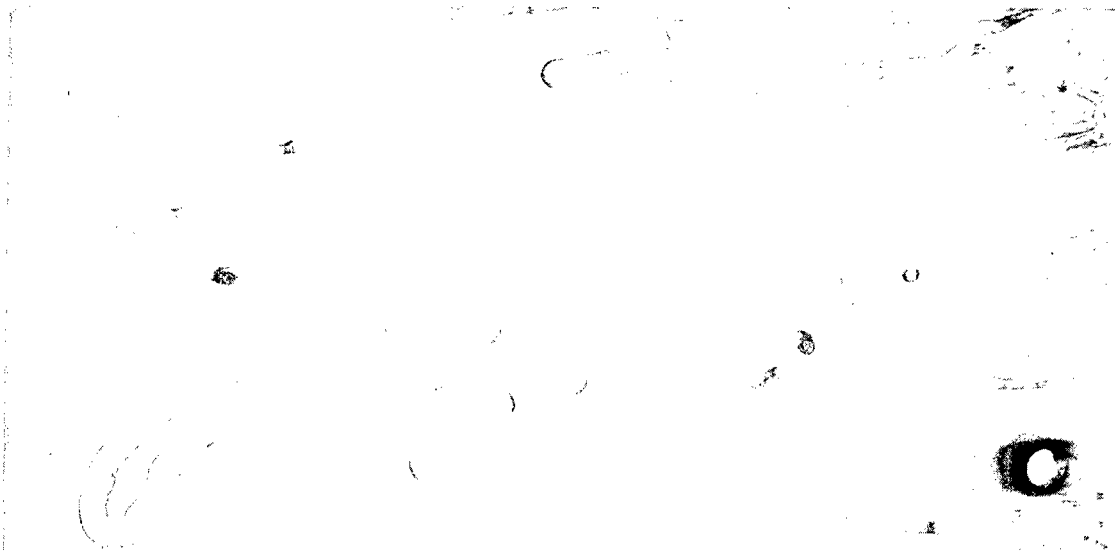

Figure 7. Radiograph of Test Panel Exposed in Vieques Sound for 10 Months at 95 Feet. Long tubes represent an early, light set of borers; short tubes are from a more recent, heavier set.

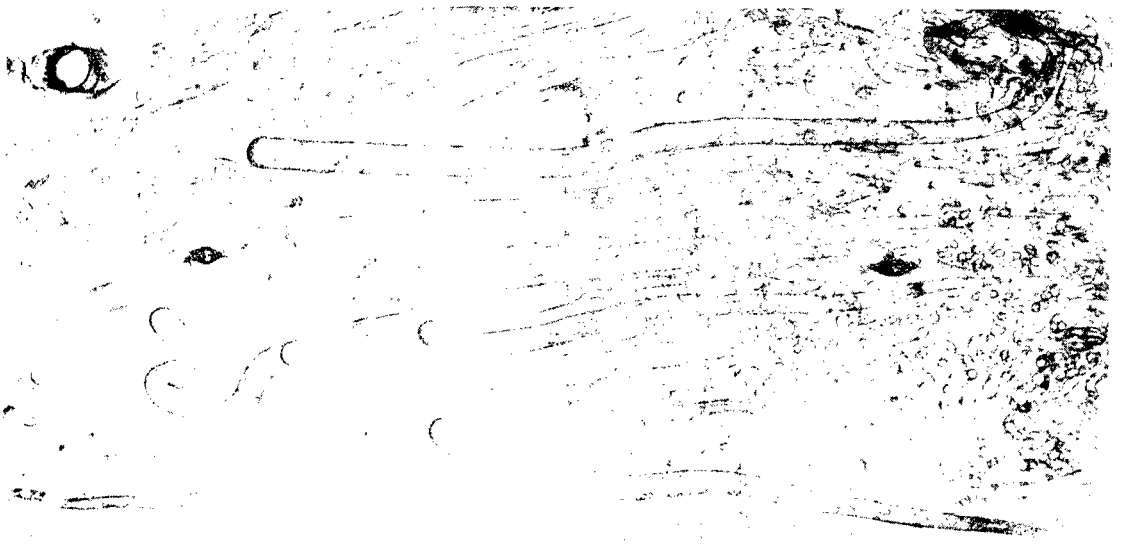

Figure 8. Radiograph of Test Panel Exposed in Vieques Sound for 12 Months at 95 Feet. Wood damage is so extensive that this panel can be easily broken with the fingers.

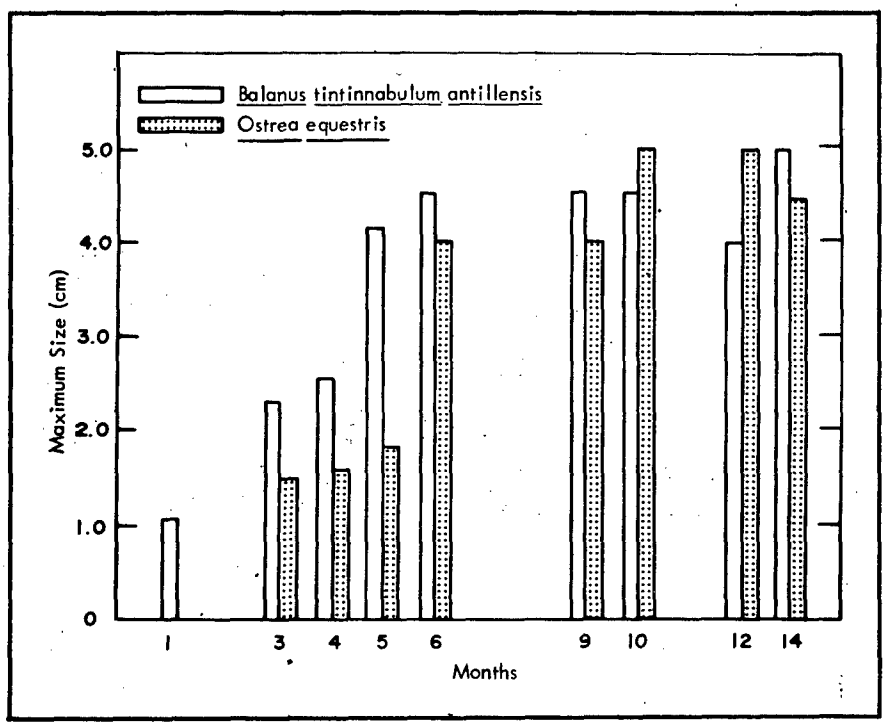

Figure 9. Growth Rates of Two Important Fouling Organisms from Vieques Sound

Table 1. Relative Abundance of Biofouling Organisms on Test Panels Exposed at Two Depths in Vieques Sound - April 1964 To February 1969

Organisms	Local Abundance	
	50-foot Panels	95-foot Panels
ALGAE		
Pocockiella sp.	XXX	XX
Desmarestia lingulata	X	-
D. aculeata	X	-
Polysiphonia opaca	XX	X
Hymenena media	X	-
Dictyota dichotoma	XX	XX
Jania adherens	X	-
Antithamnion plumula	X	-
Enantiocladia duperreyi	XX	-
Corallina cubensis	-	X
Melobesieae	XXX	XX
Chrysonephos lewisii	XX	XX
PORIFERA		
Sycon sp.	X	XX
COELENTERATA		
Eudendrium distichum	-	XXX
Tubulariidae	XX	X
Telesto sp.	XX	XX
BRYOZOA		
Thalamoporella distorta	XXX	XXX
Celleporaria albirostris	X	X
Schizoporella unicornis	-	X
Savignyella lafonti	XX	XX
Catenicella contei	XX	XX
ANNELIDA		
Hydroides parvus	XX	XX
H. norvegica	X	XX
H. dianthus	-	X
H. lunulifera	X	-
Pomatoceros triqueter	-	X
Crosslandii multispinosa	-	X
Spirobranchus giganteus	-	X
Vermiliopsis infundibulum	X	-
Pomatostegus latiscapus	X	X
Serpula vermicularis	-	X
Salmacina incrustans	-	X

Table 1. (Continued)

Organisms	Local Abundance	
	50-foot Panels	95-foot Panels
ARTHROPODA		
Balanus tintinnabulum	XX	X
B. venustus niveus	X	X
B. trigonus	XX	XX
Tetraclita radiata	XX	-
Limnoria tripunctada	-	X^1
MOLLUSCA		
Ostrea equestris	XX	XXX
O. frons	XX	XX
Chama macrophylla	XX	XX
Pycnodonta thomasi	-	XX
Musculus lateralis	XX	XX
Spondylus americanus	X	XX
Pinctada radiata	XX	X
Brevimalleus candeanus	X	-
Pteria colymbus	XX	-
Pinna carnea	X	-
Lyrodus pedicellatus	XX^2	XX^2
Bankia carinata	XX^2	XX^2
Teredora malleolus	XX^2	XX^2
Teredothyra dominicensis	-	XX^2
T. matocotana	-	XX^2
CHORDATA (Tunicata)		
Botrylloides sp.	XX	XX
Styela partita	X	X

X - never exceeds 1 % coverage of cumulative panels or occurs rarely.
XX - less than 40 % coverage of cumulative panels.
XXX - 40 % coverage or greater on cumulative panels.
X^1 Marine borer. 10-25 % of 12-month wooden panel destroyed by this and other molluscan borers.
XX^2 Marine borer. 26-50 % of 12-month wooden panel destroyed by this and other molluscan borers.

Table II. Dry Weight Production (in gms/m^2) on Test Panels Exposed in Vieques Sound

Months of Exposure	Apr.'64–Feb.'65		Dec.'65–May'67		Mar.'67–Jan.'68		Nov.'67–Nov.'68	
	50-foot	95-foot	50-foot	95-foot	50-foot	95-foot	50-foot	95-foot
1	<50	< 50	<50	<50	<50	56	-	-
2	<50	< 50	<50	<50	<50	<50	-	-
3	<50	< 50	188	61	<50	-	-	-
4	55	146	90	90	<50	99	-	-
5	281	331	524	128	-	-	-	-
6	319	223	1,094	727	155	686	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	439	236	-	-
9	-	-	2,025	-	-	-	-	-
10	655	571	-	1,112	517	1,361	-	-
11	-	-	-	-	-	-	-	-
12	-	-	2,014	-	-	-	697	2,227
14	-	-	2,509	1,462	-	-	-	-
15	-	-	1,892	-	-	-	-	-
17	-	-	2,183	1,163	-	-	-	-

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